MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2019/2020

DEE5016 –ELECTRONICS 1

(Diploma in Electronic Engineering)

22 OCTOBER 2019
2:30 PM –4:30 PM
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 6 pages excluding the cover page and appendixes with 4 questions.

2. Answer **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in the answer booklet provided.

QUESTION 1 [25 marks]

a)

Trivalent atom is an atom which has three valence electrons. Meanwhile, pentavalent atom is an atom which has five valence electrons. Both are used in doping process to produce semiconductors.

From the above statement, describe the formation of two semiconductor types using the atoms above. (10 marks)

b)

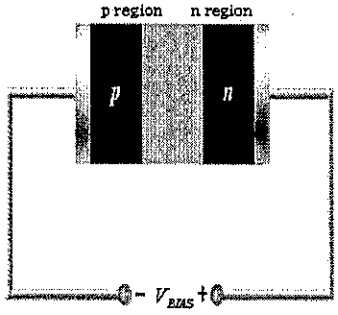

Figure Q1

Figure Q1 shows a certain diode bias connection. Based on the figure above, answer the following:

(i) Define the diode bias condition (2 marks)

(ii) Explain its basic operation (7 marks)

(iii) Draw the *V-I* characteristics curve for the above circuit connection. (1 mark)

c) Briefly explain when the diode achieves equilibrium state during the formation of depletion region. (5 marks)

Continued ...

QUESTION 2 [25 marks]

a) Figure Q2(a) and Figure Q2(b) below show two types of diode applications respectively.

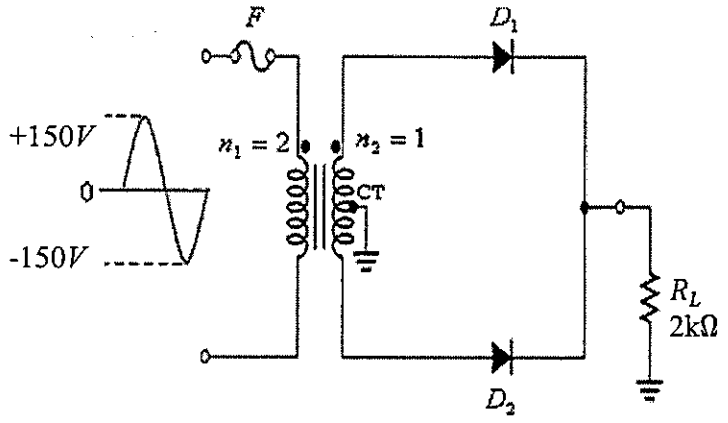

Figure Q2(a)

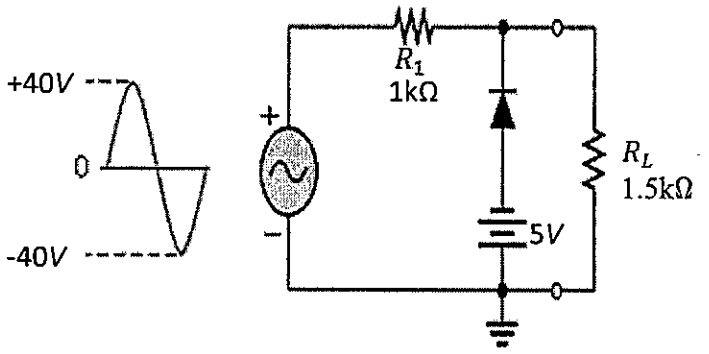

Figure Q2(b)

(i) Calculate and sketch the output voltage, $V_{p(out)}$ across R_L for Figure Q2(a). (6 marks)

(ii) Calculate and sketch the output voltage, $V_{p(out)}$ across R_L for Figure Q2(b). (5 marks)

b) State and sketch **TWO (2)** types of optical diode. Then, explain the basic operation for both optical diodes. (2+2+4 marks)

Continued ...

c) A certain special purpose diode has an impedance, $Z_Z = 4.7\ \Omega$. Given that test voltage, $V_{ZT} = 9\ V$ at test current, $I_{ZT} = 40\ mA$ and knee current, $I_{ZK} = 5\ mA$. Determine the following:

(i) The terminal voltage across the zener terminals when the current is $60\ mA$.
(5 marks)

(ii) The terminal voltage across the zener terminals when the current is $4\ mA$?
(1 mark)

Continued ...

QUESTION 3 [25 marks]

a) Figure Q3(a) shows a transistor circuit bias. Assume the transistor is made of silicon. If $\beta_{DC} = 100$, determine the following:

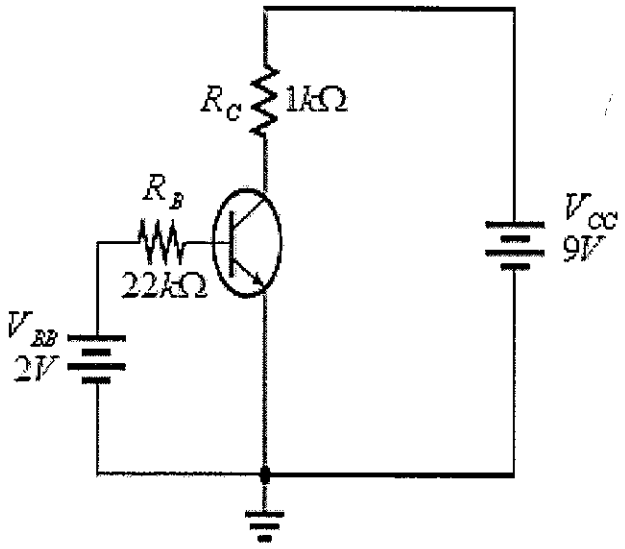

Figure Q3(a)

(i) Voltage at base with respect to emitter, V_{BE} (1 mark)
(ii) Base current, I_B (3 marks)
(iii) Collector curent, I_c (2 marks)
(iv) Emitter current, I_E (2 marks)
(v) Voltage at collector with respect to emitter, V_{CE} (2 marks)
(vi) Voltage at collector with respect to base, V_{CB} (2 marks)
(vii) DC alpha, α_{DC} (2 marks)

Continued ...

b) Figure Q3(b) shows a common-emitter amplifier. Given that V_{cc} = 10 V and assuming that $R_{IN(BASE)} \geq 10R_2$, calculate the following:

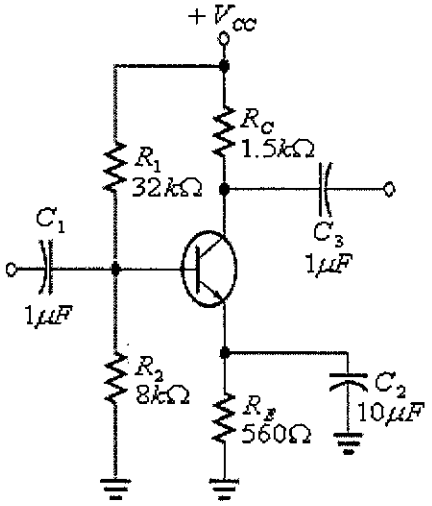

Figure Q3(b)

(i) Emitter current, I_E (5 marks)
(ii) Ac emitter resistance , r'_e in BJT (2 marks)
(iii) Voltage gain, A_v when C_2 exist (2 marks)
(iv) Voltage gain, A_v when C_2 not exist (2 marks)

Continued ...

QUESTION 4 [25 marks]

a) Define the **DC load line** in the characteristic curve of a BJT transistor. (1 mark)

b) Figure Q4 shows a certain BJT bias method. If the transistor is made from silicon, determine the following:

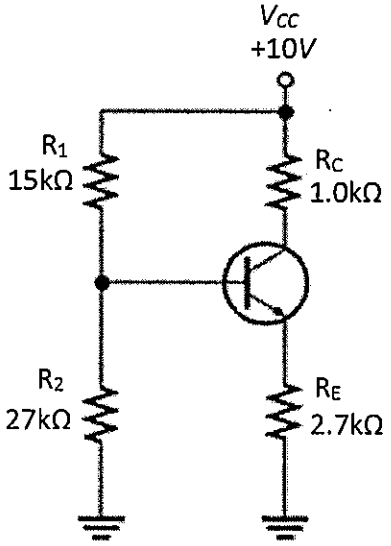

Figure Q4

(i) Identify the bias method. (1 mark)
(ii) The value of Q-point if $\beta_{DC} = 200$ (9 marks)

c) An emitter bias circuit for BJT is having the following parameters: $R_C = 4.2k\Omega$, $R_B = 55k\Omega$, $R_E = 9.5k\Omega$, $V_{CC} = 20V$, $V_{EE} = -20V$ and $\beta_{DC} = 130$.

(i) Sketch the circuit diagram. (5 marks)
(ii) evaluate the Q-point of the circuit. (9 marks)

End of Page.

FORMULAE LIST

JT BIAS	
TERMS	**FORMULAE**
DC load line equation	$I_C = -\frac{1}{R_C}V_{CE} + \frac{V_{CC}}{R_C}$
Voltage divider-bias:	
DC collector and emitter current	$I_C \cong I_E = \frac{V_E}{R_E}$
DC base voltage	$V_B = \frac{R_2 // R_{IN(BASE)}}{R_1 + (R_2 // R_{IN(BASE)})} \times V_{CC}$ $V_B = \frac{R_2}{R_1 + R_2} \times V_{CC}$ if, $R_{IN(BASE)} >> R_2$
DC collector voltage	$V_C = V_{CC} - I_C R_C$
DC collector-to-emitter voltage	$V_{CE} = V_{CC} - I_C(R_C + R_E)$
DC emitter voltage	$V_E = V_B - V_{BE}$
DC input resistance at the base	$R_{IN(BASE)} = \beta_{DC} R_E$
DC total resistance	$R_T = R_2 // \beta_{DC} R_E$
Base bias:	
DC base current	$I_B = \frac{V_{CC} - V_{BE}}{R_B}$
DC collector current	$I_C = \frac{\beta_{DC}(V_{CC} - V_{BE})}{R_B}$
DC collector-to-emitter voltage	$V_{CE} = V_{CC} - I_C R_C$

Collector-feedback bias:	
DC base current	$I_B = \frac{V_C - V_{BE}}{R_B}$
DC collector current	$I_C = \frac{V_{CC} - V_{BE}}{\frac{R_B}{\beta_{DC}} + R_C}$
DC collector-to-emitter voltage	$V_{CE} = V_{CC} - I_C R_C$
Emitter bias:	
DC base current	$I_B \cong \frac{I_E}{\beta_{DC}}$
DC collector current	$I_C \cong \frac{-V_{EE} - V_{BE}}{\frac{R_B}{\beta_{DC}} + R_E}$
DC emitter current	$I_E = \frac{-V_{EE} - V_{BE}}{\frac{R_B}{\beta_{DC}} + R_E}$
DC base voltage	$V_B = V_E + V_{BE}$
DC collector voltage	$V_C = V_{CC} - I_C R_C$
DC collector-to-emitter voltage	$V_{CE} = V_C - V_E$
DC emitter voltage	$V_E = V_{EE} + I_E R_E$

BJT AMPLIFIERS	
TERMS	**FORMULAE**
***r* Parameters:**	
ac base resistance	$r_b^{'} = h_{ie} - \frac{h_{re}\left(h_{fe}+1\right)}{h_{oe}}$
ac collector resistance	$r_c^{'} = \frac{h_{re}+1}{h_{oe}}$
ac emitter resistance	$r_e^{'} = \frac{h_{re}}{h_{oe}}$
Common-base amplifier:	
DC emitter current	$I_E = \frac{V_E}{R_E}$
DC base voltage	$V_B = \frac{R_2}{R_1+R_2} \times V_{CC}$
DC emitter voltage	$V_E = V_B - V_{BE}$
ac output voltage	$V_{out} = V_c$
ac input voltage	$V_{in} = V_e$
ac resistance at emitter	$R_{in(emitter)} \cong r_e^{'}$
ac output resistance	$R_{out} \cong R_C$
Current gain	$A_i \cong 1$

Voltage gain	$A_v \cong \frac{R_c}{r_e'}$
Power gain	$A_p = A_v$
Common-collector amplifier:	
ac input current	$I_{in} = \frac{V_{in}}{R_{in(tot)}}$
ac emitter current	$I_e = \frac{V_e}{R_e}$
ac emitter voltage	$V_e = A_v V_b$
ac input resistance at base	$R_{in(base)} \cong \beta_{ac} R_e$
ac total input resistance	$R_{in(tot)} = R_1 // R_2 // R_{in(base)}$
ac output resistance	$R_{out} \cong \left(\frac{R_s}{\beta_{ac}}\right) // R_E$
Current gain	$A_i = \frac{I_e}{I_{in}}$
Voltage gain	$A_v \cong 1$
Power gain	$A_p = A_i$
Common-emitter amplifier:	
DC collector current	$I_C \cong I_E$

DC base voltage	$V_B = \frac{R_2}{R_1 + R_2} \times V_{CC}$
DC collector voltage	$V_C = V_{CC} - I_C R_C$
DC collector-to-emitter voltage	$V_{CE} = V_C - V_E$
DC emitter current	$I_E = \frac{V_E}{R_E}$
DC emitter voltage	$V_E = V_B - V_{BE}$
DC input resistance at base	$R_{IN(BASE)} = \beta_{DC} R_E$
ac base current	$I_b \cong \frac{I_e}{\beta_{ac}}$
ac base voltage	$V_b = \frac{R_{in(tot)}}{R_s + R_{in(tot)}} \times V_s$ $= I_e r_e'$
ac collector voltage	$V_c = A_v' V_x$
ac total current signal	$I_s = \frac{V_s}{R_{in(tot)} + R_s}$
ac input resistance at base	$R_{in(base)} = \beta_{ac} r'_e$
ac total input resistance	$R_{in(tot)} = R_1 // R_2 // R_{in(base)}$

ac output resistance	$R_{out} \cong R_C$
Current gain	$A_i = \frac{I_c}{I_s}$
Voltage gain	$A_v = \frac{R_C}{r_e'}$ if C_2 exists $A_v = \frac{R_C}{r_e' + R_E}$ if C_2 does not exist
Overall voltage gain	$A_v' = Attenuation \times A_v$
Power gain	$A_p = A_v' A_i$